“A STUDY OF NATIONAL KABADDI PLAYERS AND NATIONAL INDIVIDUAL GAME PLAYERS WITH RESPECT TO VRT, ART, EXTRAVERSION AND NEUROTICISM”

Chapter – I

Introduction:

Speed of movement and quick reactions are prized qualities in athletics. For example, this factor partly determines how successful a basketball player or a soccer player can be, on defense. When the offensive player makes his move, the difference between a slow and a fast reaction by the defensive player can determine his success or failure. Both offensive and defensive players are often hindered by slow reactions because they are not able to demonstrate the quickness necessary to outmaneuver their opponents. Similar examples could be stated in connection with tennis, badminton, football, and several other court and field games. Further, reaction time is of obvious importance in all combative activities. The reaction time is often overlooked and usually underestimated element in the selection of athletes for different sports. In sports and games, in which movements of a participant are conditioned by signals, by movements of opponents, or by motion of the ball, reaction time is of great importance. A sprinter who can start faster than other contestants; a baseball catcher who can react faster to the change in the direction of the motion of the ball; a ping pong player who is always in the right place at the right time- all have a definite advantage over slower reacting men duration of reaction time, athletes and coaches are starting to realize importance of reaction time in sports performance. Because of
this realization, research is necessary to scientifically show athletes and coaches the
effect of reaction time on their sports performance so that it will be useful to screen a
large population for physical fitness. The study of relation of the reaction time to
motor skill performance in sport is not new, but in the past not much attention was
given to elite athletes.

Reaction time is the elapsed time between the presentation of a sensory
stimulus and the subsequent behavioral response. Simple reaction time is usually
defined as the time required for an observer to detect the presence of a stimulus. It is a
physical skill closely related to human performance. It represents the level of
neuromuscular coordination in which the body through different physical, chemical
and mechanical processes decodes visual or auditory stimuli which travel via afferent
pathways and reach the brain as sensory stimuli.

Speed of movement and quick reactions are prized qualities in athletics. For
example, this factor partly determines how successful a basketball player or a soccer
player can be, on defense. When the offensive player makes his move, the difference
between a slow and a fast reaction by the defensive player can determine his success
or failure. Both offensive and defensive players are often hindered by slow reactions
because they are not able to demonstrate the quickness necessary to outmaneuver their
opponents. Similar examples could be stated in connection with tennis, badminton,
football, and several other court and field games. Further, reaction time is of obvious
importance in all combative activities. The reaction time is often overlooked and
usually underestimated element in the selection of athletes for different sports. In
sports and games, in which movements of a participant are conditioned by signals, by
movements of opponents, or by motion of the ball, reaction time is of great
importance. A sprinter who can start faster than other contestants; a baseball catcher who can react faster to the change in the direction of the motion of the ball; a ping pong player who is always in the right place at the right time - all have a definite advantage over slower reacting men. Duration of reaction time, athletes and coaches are starting to realize importance of reaction time in sports performance. Because of this realization, research is necessary to scientifically show athletes and coaches the effect of reaction time on their sports performance so that it will be useful to screen a large population for physical fitness. The study of relation of the reaction time to motor skill performance in sport is not new, but in the past not much attention was given to elite athletes.

**Reaction time**

Reaction time is the elapsed time between the presentation of a sensory stimulus and the subsequent behavioral response. RT is often used in experimental psychology to measure the duration of mental operations, an area of research known as mental chronometry. The behavioral response is typically a button press but can also be an eye movement, a vocal response, or some other observable behavior.

**Types of tasks**

Simple reaction time is usually defined as the time required for an observer to detect the presence of a stimulus. For example, an observer might be asked to press a button as soon as a light or sound appears. Mean RT for young adults is approximately 190 milliseconds to detect visual stimuli, and approximately 160 milliseconds to detect auditory stimuli. Go/No-Go reaction time tasks require that the observer press a button when one stimulus type appears and withhold a response when other stimulus types appear. For example, the observer is to press the button when a red light appears and not respond when a green light appears. Choice reaction time tasks require
distinct responses for each possible class of stimulus. For example, the observer may
be asked to press one button if a red light appears and a different button if a yellow
light appears.

History
Abū Rayhān al-Bīrūnī was the first to describe the concept of reaction time:
"Not only is every sensation attended this by a corresponding change localized in the
sense-organ, which demands a certain time between the stimulation of the organ and
consciousness of the perception an interval of time must elapse, corresponding to the
transmission of stimulus for some distance along the nerves."
Franciscus Donders was among the first to systematically analyze human RT to
measure the duration of mental operations.

Experimental psychology approaches psychology as one of the natural sciences,
investigates it using the experimental method. The focus of experimental psychology
is on discovering the underlying processes behind behavior and the specific nature of
mental life. This is in contrast to applied psychology, which employs psychological
knowledge to solve real-world problems, and clinical psychology, which aims to treat
mental illness with therapy.

Experimental psychology is a methodological approach rather than a subject and
encompasses varied fields within psychology more broadly, many of which are
studied using other methodologies like hermeneutics. Experimental psychologists
have traditionally conducted research, published articles, and taught classes on
neuroscience, developmental psychology, sensation, perception, consciousness,
learning, memory, thinking, and language. Recently, however, the experimental
approach has extended to motivation, emotion, and social psychology.
Early experimental psychology

While the origins of experimental psychology can be traced as far back as the eleventh century, when Ibn al-Haytham (Alhacen) used an experimental approach to visual perception and optical illusions in the Book of Optics in 1021 and Abū Rayhān Bīrūnī discovered the concept of reaction time, experimental psychology emerged as a modern academic discipline in the 19th century when Wilhelm Wundt introduced a mathematical and experimental approach to the field and founded both the first psychology laboratory in Leipzig, Germany and the structuralist school of psychology. Other early experimental psychologists, including Hermann Ebbinghaus and Edward Titchener, included introspection among their experimental methods.

20th Century

In the first half of the twentieth century, behaviourism became a dominant paradigm within psychology, especially in the United States. This led to some neglect of mental phenomena within experimental psychology. In Europe this was less the case, as European psychology was influenced by psychologists such as Sir Frederic Bartlett, Kenneth Craik, W. E. Hick and Donald Broadbent, who focused on topics such as thinking, memory and attention. This laid the foundations for the subsequent development of cognitive psychology.

In the latter half of the twentieth century, the phrase "experimental psychology" has shifted in meaning due to the expansion of psychology as a discipline and the growth in the size and number of its sub-disciplines. Experimental psychologists use a range of methods and do not confine themselves to a strictly experimental approach, partly because developments in the philosophy of science have had an impact on the exclusive prestige of experimentation. In contrast, an experimental method is now widely used in fields such as developmental and social psychology, which were not
previously part of experimental psychology. The phrase continues in use, however, in
the titles of a number of well-established, high prestige learned societies and scientific
journals, as well as some university courses of study in psychology.

Methodology

Experiments
The complexity of human behaviour and mental processes, the ambiguity with which
they can be interpreted and the unconscious processes to which they are subject gives
rise to an emphasis on sound methodology within experimental psychology.

Control of extraneous variables, minimizing the potential for experimenter bias,
counterbalancing the order of experimental tasks, adequate sample size, and the use of
operational definitions which are both reliable and valid, and proper statistical
analysis are central to experimental methods in psychology. As such, most
undergraduate programmes in psychology include mandatory courses in Research
Methods and Statistics.

Other Methods
While other methods of research - case study, correlational, interview, and naturalistic
observation - are practiced within fields typically investigated by experimental
psychologists, experimental evidence remains the gold standard for knowledge in
psychology. Many experimental psychologists have gone further, and have treated all
methods of investigation other than experimentation as suspect. In particular,
experimental psychologists have been inclined to discount the case study and
interview methods as they have been used in clinical.

Criticism
Critical and postmodernist psychologists conceive of humans and human nature as
inseparably tied to the world around them, and claim that experimental psychology
approaches human nature and the individual as entities independent of the cultural, economic, and historical context in which they exist. At most, they argue, experimental psychology treats these contexts simply as variables effecting a universal model of human mental processes and behaviour rather than the means by which these processes and behaviours are constructed. In so doing, critics assert, experimental psychologists paint an inaccurate portrait of human nature while lending tacit support to the prevailing social order.

Three days before his death, radical behaviourist B.F. Skinner criticized experimental psychology in a speech to the American Psychological Association for becoming increasingly "mentalistic" - that is, focusing research on internal mental processes instead of observable behaviours. This criticism was levelled in the wake of the cognitive revolution wherein behaviourism fell from dominance within psychology and functions of the mind were given more credence.

**Mental chronometry** is the use of response time in perceptual-motor tasks to infer the content, duration, and temporal sequencing of cognitive operations. Mental chronometry is one of the core paradigms of experimental and cognitive psychology, and has found application in various disciplines including cognitive psychophysiology/cognitive neuroscience and behavioral neuroscience to elucidate mechanisms underlying cognitive processing.

History: Donders' experiment

Psychologists have developed and refined mental chronometry for over the past 100 years. Seminal early studies in reaction time were conducted by Franciscus Donders (1869).
Donders (1868’s): method of subtraction. Picture from the ‘Historical Introduction to Cognitive Psychology’ webpage.

Donders devised a subtraction method to analyze cognitive activity into separate stages, each of which requires some fairly constant time to complete. The method involved three tasks:

1. A simple reaction time task. For example, you are seated in front of a panel that contains a light bulb and a response button. When the light comes on, you must press the button.

2. A discrimination reaction time task. For example, you are seated in front of a panel with two light bulbs and one response button. When a prespecified target light (e.g., the one on the left) is illuminated, you must press the button, but not if the one on the right is illuminated.

3. A choice reaction time task. For example, you are seated in front of two light bulbs, each with their own button. You must press the button corresponding to the illuminated light.

Donders then predicted the kinds of processes that might be involved in each task:

1. A simple reaction time task would require perception and motor stages (the time to perceive the light and then execute the response).
2. A discrimination reaction time task requires the above + a perceptual discrimination stage.

3. A choice reaction time task requires all of the above + a response selection stage.

As expected, simple tasks take the shortest amount of time, followed by discrimination tasks, with choice tasks taking the longest amount of time. Donders calculated the time required for each stage by using a subtraction technique:

1. Perception and motor time = time required for simple task
2. Perceptual discrimination time = time for discrimination task - simple task
3. Response selection time = time for choice task - discrimination task.

This method provides a way to investigate the cognitive processes underlying simple perceptual-motor tasks, and formed the basis of subsequent developments, as discussed in the next section.

**Development of mental chronometry in cognitive psychology**

**Posner’s letter matching studies**

Posner (1978) used a series of letter-matching studies to measure the mental processing time of several tasks associated with recognition of a pair of letters. The simplest task was the physical match task, in which subjects were shown a pair of letters and had to identify whether the two letters were physically identical or not. The next task was the name match task where subjects had to identify whether two letters had the same name. The task involving the most cognitive processes was the rule match task in which subjects had to determine whether the two letters presented both were vowels or not vowels. The physical match task was the most simple because mentally subjects had to encode the letters, compare them to each other, and make a decision. When doing the name match task subjects were forced to add a cognitive
step before making a decision. They had to search memory for the names of the letters, and then compare those before deciding. In the rule based task they had to also categorize the letters as either vowels or consonants before making their choice. The time taken to perform the rule match task was longer than the name match task which was longer than the physical match task. Using the subtraction method experimenters were able to determine the approximate amount of time that it took for subjects to perform each of the cognitive processes associated with each of these tasks.

**Sternberg’s memory-scanning task**

Sternberg (1966) devised an experiment wherein subjects were told to remember a set of unique digits in short-term memory. Subjects were then given a probe stimulus in the form of a digit from 0-9. The subject then answered as quickly as possible whether the probe was in the previous set of digits or not. The size of the initial set of digits was the independent variable and the reaction time of the subject was the dependent variable. The idea is that as the size of the set of digits increases the number of processes that need to be completed before a decision can be made increases as well. So if the subject has 4 items in short-term memory (STM), then after encoding the information obtained from the probe stimulus the subject will need to compare the probe to each of the 4 items in memory and then make a decision. If there were only 2 items in the initial set of digits then the number of processes would be reduced by 2.

The data from this study found that for each additional item added to the set of digits that the subject had in STM about 38 milliseconds were added to the response time of the subject. This finding supported the idea that a subject did a serial exhaustive search through memory rather than a serial self-terminating search. Sternberg (1969) developed a much-improved method for dividing reaction time into successive or serial stages, called the additive factor method.
Shepard and Metzler’s mental rotation task

Shepard and Metzler (1971) presented a pair of three-dimensional shapes that were identical or mirror-image versions of one another. Reaction time to determine whether they were identical or not was a linear function of the angular difference between their orientation, whether in the picture plane or in depth. They concluded that the observers performed a constant-rate mental rotation to align the two objects so they could be compared. Cooper and Shepard (1973) presented a letter or digit that was either normal or mirror-reversed, and presented either upright or at angles of rotation in units of 60 degrees. The subject had to identify which type of stimulus it was: normal or mirror-reversed. Response time increased roughly linearly as the orientation of the letter deviated from upright (0 degrees) to inverted (180 degrees), and then decreases again until it reaches 360 degrees. The authors concluded that the subjects mentally rotate the image the shortest distance to upright, and then judge whether it is normal or mirror-reversed.

Sentence-picture verification

Mental chronometry has been a useful tool in identifying some of the processes associated with understanding a sentence. This type of research typically revolves around the differences in processing 4 types of sentences: true affirmative (TA), false affirmative (FA), false negative (FN), and true negative (TN). A picture can be presented with an associated sentence that falls into one of these 4 categories. The subject then decides if the sentence matches the picture or does not. The type of sentence determines how many processes need to be performed before a decision can be made. According to the data from Clark and Chase (1972) and Just and Carpenter (1971), the TA sentences are the simplest and take the least time, then FA, FN, and TN sentences.
Mental chronometry and models of memory

Hierarchical network models of memory were largely discarded due to some findings related to mental chronometry. The TLC model proposed by Collins and Quillian (1969) had a hierarchical structure indicating that recall speed in memory should be based on the number of levels in memory traversed in order to find the necessary information. But the experimental results did not agree with this model. For example, a subject will reliably answer that a robin is a bird more quickly than he will answer that an ostrich is a bird despite these questions accessing the same two levels in memory. This led to the development of spreading activation models of memory (e.g., Collins & Loftus, 1975), wherein links in memory are not organized hierarchically but by importance instead.

Application of mental chronometry in biological psychology/cognitive neuroscience
Regions of the Brain Involved in a Number Comparison Task Derived from EEG and fMRI Studies. The regions represented correspond to those showing effects of notation used for the numbers (pink and hatched), distance from the test number (orange), choice of hand (red), and errors (purple). Picture from the article: ‘Timing the Brain: Mental Chronometry as a Tool in Neuroscience’.

With the advent of functional neuroimaging techniques, notably PET and fMRI, psychologists started to modify their mental chronometry paradigms for functional imaging (Posner, 2005). Although psycho(physio)logists have been using electroencephalographic measurements for decades before the conception of PET and fMRI, the images obtained with PET have attracted great interest from other branches of neuroscience, increasingly popularizing mental chronometry among a more elaborate breed of scientists in recent years. The way that mental chronometry is utilized is by performing tasks based on reaction time which measures through neuroimaging the parts of the brain which are involved in the cognitive processes.

Much research is being done now using mental chronometry and connecting it with cognitive studies however, there was extensive research being conducted in the past. In the 1950’s, the use of a micro electrode recording of single neurons in anaesthetized monkeys allowed research to look at physiological process in the brain and supported this idea that people encode information serially.

In the 1960s, these methods were used extensively in humans: researchers recorded the electrical potentials in human brain using scalp electrodes while a reaction tasks was being conducted using digital computers. What they found was that there was a connection between the observed electrical potentials with motor and sensory stages for information processing. For example, researchers found in the recorded scalp potentials that the frontal cortex was being activated in association with motor
activity. These finding can be connected to Donders’ idea of the subtractive method of the sensory and motor stages involved in reaction tasks.

Then, with the invention of functional magnetic resonance imaging (fMRI), techniques were used to measure activity through electrical event-related potentials in a study when subjects were asked to identify if a digit that was presented was above or below five. According to Sternberg’s additive theory, each of the stages involved in performing this task includes: encoding, comparing against the stored representation for five, selecting a response, and then checking for error in the response. This fMRI image presents the specific locations where these stages are occurring in the brain while performing this simple mental chronometry task.

In the 1980s, neuroimaging experiments allowed researchers to detect the activity in localized brain areas by injecting radionuclides and using positron emission tomography (PET) to detect them. Also, fMRI was used which have detected the precise brain areas that are active during mental chronometry tasks. Many studies have shown that there is a small number of brain areas which are widely spread out which are involved in performing these cognitive tasks

**The Importance Of Reaction Time In Sports Performance**

Reaction time is the ability to respond quickly with proper posture and control to a stimulus such as sound or sight. In many instances, quickness is more important than straight ahead speed. In many sports, maximum speed is rarely reached or needed, but explosive reaction is often necessary. Athletes can improve reaction times by training to make the right choices (choice reaction). Here are some examples:

1) A defensive back makes an interception because he reads the quarterbacks eyes/motions, reads the receiver's body moves, postions his body based on the receiver's actions and reacts to the thrown ball. These different stimuli could happen
in any order. The most successful defensive backs anticipate, react quickly and explosively with proper posture and control.

2) One of the most important decisions a batter makes at the plate is to "go" or "no go" i.e., whether to swing the bat or not swing. The most successful hitters are able to wait longer and react quicker. This allows the batter to read the pitch (fastball, curve, etc.) and "go" or "no go". When facing a 90+ per hour fastball, there's not much time to react.

3) Reaction time drills should be done from an athletic stance, staggered stance, kneeling position, back-to-ball position, eyes-closed position, two-point stance, etc. to simulate game-time situations. Reaction time and explosive quickness is an important part of overall speed training and the best athletes have this quality.

**Use of performance enhancing drugs in sport**

In sports, the use of performance-enhancing drugs is commonly referred to by the disparaging term "doping", particularly by those organizations that regulate competitions. The use of performance enhancing drugs is mostly done to improve athletic performance. This is why many sports ban the use of performance enhancing drugs. Another similar use of medical technology is called blood doping, either by blood transfusion or use of the hormone erythropoietin (EPO). The use of drugs to enhance performance is considered unethical by most international sports organizations and especially the International Olympic Committee, although ethicists have argued that it is little different from the use of new materials in the construction of suits and sporting equipment, which similarly aid performance and can give competitors advantage over others. The reasons for the ban are mainly the alleged health threat of performance-enhancing drugs, the equality of opportunity for athletes and the supposedly exemplary effect of "clean" ("doping-free") sports in the public.
This entry concerns the use of performance-enhancing drugs by humans. The use of such drugs is also common in horse racing and other equestrian sports, and in greyhound racing, horses and greyhounds. Here are many suggestions as to the origin of the word ‘doping’. One is that it is derived from ‘dop’ an alcoholic drink used as a stimulant in ceremonial dances in 18th century Southern Africa. Another suggestion is that the word comes from the Dutch word ‘doop’ (a thick dipping sauce) that entered American slang to describe how robbers stupefied victims by mixing tobacco with the seeds of Datura stramonium, known as jimsonweed, which contains a number of tropane alkaloids, causing sedation, hallucinations and confusion. By 1889, ‘dope’ was used in connection with the preparation of a thick viscous preparation of opium for smoking, and during the 1890s this extended to any stupefying narcotic drug. In 1900, dope was also defined as ‘a preparation of drugs designed to influence a racehorse’s performance’.

Texts going back to antiquity suggest that men have always sought a way to work harder or at least to suffer less as they were doing so. When the fittest of a nation were selected as athletes or combatants, they were fed diets and given treatments considered beneficial. Scandinavian mythology says Berserkers could drink a mixture called "butotens", perhaps prepared from the Amanita muscaria mushroom, and increase their physical power a dozen times at the risk of "going crazy". In more recent times, the German missionary and doctor Albert Schweitzer wrote of Gabon in the early 19th century: "The people of the country can, having eaten certain leaves or roots, toil [pagayer] vigorously all day without feeling hungry, thirsty or tired and all the time showing a happiness and gaiety."

A participant in an endurance walking race in Britain, Abraham Wood, said in 1807 that he had used laudanum, or opium, to keep him awake for 24 hours while
competing against Robert Barclay Allardyce. By April 1877, walking races had stretched to 500 miles and the following year, also at the Agricultural Hall in Islington, London, to 520 miles. The Illustrated London News chided:

It may be an advantage to know that a man can travel 520 miles in 138 hours, and manage to live through a week with an infinitesimal amount of rest, though we fail to perceive that anyone could possibly be placed in a position where his ability in this respect would be of any use to him [and] what is to be gained by a constant repetition of the fact.

The crowd loved it, however, and 20,000 a day came to watch. That encouraged promoters to repeat the races, at the same venue but with cyclists. They were the fastest humans on earth...

and much more likely to endure their miseries publicly; a tired walker, after all, merely sits down - a tired cyclist falls off and possibly brings others crashing down as well. That's much more fun.

The fascination with six-day bicycle races spread across the Atlantic and the same appeal to base instincts brought in the crowds in America as well. And the more spectators paid at the gate, the higher the prizes could be and the greater was the incentive of riders to stay awake - or be kept awake - to ride the greatest distance.

Their exhaustion was countered by soigneurs (the French word for "carers"), helpers akin to seconds in boxing. Among the treatments they supplied was nitroglycerine, a drug used to stimulate the heart after cardiac attacks and which was credited with improving riders' breathing. Riders suffered hallucinations from the exhaustion and perhaps the drugs. The American champion Major Taylor refused to continue the New York race, saying: "I cannot go on with safety, for there is a man chasing me around the ring with a knife in his hand."
Public reaction turned against such trials, whether individual races or in teams of two. One report chided:

An athletic contest in which the participants 'go queer' in their heads, and strain their powers until their faces become hideous with the tortures that rack them, is not sport, it is brutality. It appears from the reports of this singular performance that some of the bicycle riders have actually become temporarily insane during the contest. Days and weeks of recuperation will be needed to put the racers in condition, and it is likely that some of them will never recover from the strain.

The American specialist in doping, Max M. Novich, wrote: "Trainers of the old school who supplied treatments which had cocaine as their base declared with assurance that a rider tired by a six-day race would get his second breath after absorbing these mixtures." John Hoberman, a professor at the University of Texas in Austin, Texas, said six-day races were "de facto experiments investigating the physiology of stress as well as the substances that might alleviate exhaustion."

**Strychnine at the Olympics**

These "de facto experiments investigating the physiology of stress as well as the substances that might alleviate exhaustion" weren't unknown outside cycling.

Thomas J. Hicks, an American born in England on January 7, 1875 won the Olympic marathon in 1904. He crossed the line behind a fellow American, Fred Lorz, whose concept of marathon-running extended to riding half the way in a car. But nor did Hicks compete without outside help. His trainer, Charles Lucas, pulled out a hypodermic and came to his aid as his runner began to struggle.

I therefore decided to inject him with a milligram of sulphate of strychnine and to make him drink a large glass brimming with brandy. He set off again as best he could
[but] he needed another injection four miles from the end to give him a semblance of speed and to get him to the finish.

The use of strychnine, far from being banned, was thought necessary to survive demanding races, says the sports historian Alain Lunzenfichter. The historian of sports doping, Dr Jean-Pierre de Mondenard, said:

It has to be appreciated that at the time the menace of doping for the health of athletes or of the purity of competition had yet to enter the morals because, after this marathon, the official race report said: The marathon has shown from a medical point of view how drugs can be very useful to athletes in long-distance races.

Hicks hung, in the phrase of the time, "between life and death" but recovered and collected his gold medal a few days later, although he never again took part in athletics.

**Reaction from sports organizations**

Many sports organizations have banned the use of performance enhancing drugs and have very strict rules and consequences for people who are caught using them. The International Amateur Athletic Federation, now the International Association of Athletics Federations, were the first international governing body of sport to take the situation seriously. In 1928 they banned participants from doping, but with little in the way of testing available they had to rely on the word of the athlete that they were clean.

It was not until 1966 that FIFA (soccer) and Union Cycliste Internationale (cycling) joined the IAAF in the fight against drugs, closely followed by the International Olympic Committee the following year.
Progression in pharmacology has always outstripped the ability of sports federations to implement rigorous testing procedures but since the creation of the World Anti-Doping Agency in 1999 more and more athletes are being caught. The first tests for athletes were at the 1966 European Championships and two years later the IOC implemented their first drug tests at both the Summer and Winter Olympics. Anabolic steroids became prevalent during the 1970s and after a method of detection was found they were added to the IOC's prohibited substances list in 1976. Over the years, different sporting bodies have evolved differently to the war against doping. Some, such as athletics and cycling, are becoming increasingly vigilant against doping in their sports. However, there has been criticism that sports such as soccer and baseball are doing nothing about the issue, and letting athletes implicated in doping away unpunished. An example of this was Operation Puerto - approximately 200 sportspersons were implicated in blood doping. Of these, approximately 50 were cyclists and 150 were other sportspersons, including several "high profile soccer and tennis players". The cyclists were pursued over their involvement, with many of them getting bans, such as Ivan Basso and Tyler Hamilton. By contrast, not a single soccer player involved in the doping ring was named, and to this day, all remain unpunished.

A handful of commentators maintain that, as outright prevention of doping is an impossibility, all doping should be legalised. However, most disagree with this assertion, pointing out the claimed harmful long-term effects of many doping agents. However, with no medical data to support these claimed health problems, it is questionable at best. Opponents claim that with doping legal, all competitive athletes would be compelled to use drugs, the net effect would be a level playing field but with widespread health consequences. However, considering that anti-doping is
largely ineffective due to both testing limitations and lack of enforcement, this is not markedly different than the situation already in existence. Another point of view is that doping could be legalized to some extent using a drug whitelist and medical counseling, such that medical safety is ensured, with all usage published. However, under such a system, it is likely that athletes would attempt cheat by exceeding official limits to try to gain an advantage; however, this is pure conjecture as drug amounts do not always correlate linearly with performance gains. Thus, to police such a system could be as difficult as policing a total ban on performance enhancing drugs.

The Anti-Doping Convention of the Council of Europe in Strasbourg was opened for signature on 16 December 1989 as the first multilateral legal standard in this field. It has been signed by 48 states including the Council of Europe non-member states Australia, Belarus, Canada and Tunisia. The Convention is open for signature by other non-European states. It does not claim to create a universal model of anti-doping, but sets a certain number of common standards and regulations requiring Parties to adopt legislative, financial, technical, educational and other measures. The main objective of the Convention is to promote the national and international harmonisation of the measures to be taken against doping. In their constitutional provisions, each contracting party undertakes to:

- create a national co-ordinating body;
- reduce the trafficking of doping substances and the use of banned doping agents;
- reinforce doping controls and improve detection techniques;
- support education and awareness-raising programmes;
- guarantee the efficiency of sanctions taken against offenders;
- collaborate with sports organisations at all levels, including at international level;
and to use accredited anti-doping laboratories.

Furthermore the Convention describes the mission of the Monitoring Group set up in order to monitor its implementation and periodically re-examine the List of prohibited substances and methods which can be found in annex to the main text.

An Additional Protocol to the Convention entered into force on 1 April 2004 with the aim of ensuring the mutual recognition of anti-doping controls and of reinforcing the implementation of the Convention using a binding control system.

**Statistical Validity**

Professor Donald A. Berry has argued that the closed systems used by anti-doping agencies do not allow scientific (statistical) validation of the tests. This argument was seconded by an accompanying editorial in the magazine Nature (7 August 2008).

**Don Catlin**

In 1982, Don Catlin founded the UCLA Olympic Analytical Laboratory, the first anti-doping lab in the United States, which he directed for the next 25 years. The lab was responsible for testing at the Olympic, professional and collegiate levels and grew to become the world’s largest testing facility. In the 1990s, Catlin's lab was first to offer the carbon isotope ratio test, a urine test that determines whether anabolic steroids are made naturally by the body or come from a prohibited performance-enhancing drug.

In 2002 at the Winter Olympics in Salt Lake City, he reported darbepoetin alfa, a form of the blood booster EPO (erythropoietin), for the first time in sports.

In 2002, he identified norbolethone, the first reported designer anabolic steroid used by an athlete. In 2003, as a key part of the investigation of BALCO, he identified and developed a test for tetrahydrogestrinone (THG) or “The Clear,” the second reported designer anabolic steroid. Later that year, the Chicago Tribune named Catlin Sportsman of the Year. In 2004, he identified madol, the third reported designer
anabolic steroid, also known as “DMT,” and since 2004 he and his team have identified several more designer steroids.

**About Reaction Time**

Reaction time is the ability to respond quickly to a stimulus. It important in many sports and day to day activities, though it is not often measured. Simple reaction time is the time taken between a stimulus and movement e.g., sprint start. Such simple reaction time depends on nerve connections and signal pathways, is 'hard wired' in your body composition and cannot be improved. Another type of reaction time, choice reaction time, is the time taken between stimulus and action which requires a choice. Choice reaction time can be improved by practice and training.

Performers receive stimuli from the eyes (position of other players, the ball etc), the ears (calling from players, the referee, even spectators), and kinesthetic sense (the performer's position, their options etc). Skilled players reduce reaction time by selecting the most important information, and by anticipating other players actions and the path of the ball quickly.

**Testing Reaction Time**

As with all sports fitness testing, specificity is very important, and if you were to seriously want to measure an athlete's reaction time in a certain sport, you would want a test that is more specific to the visual cues and muscle reactions that are encountered during that sport. See a list of reaction time tests.

**What is it measuring?**

For example, in the click reaction time test, when you see the screen color change, the signal for the change in color travels from your eye along the optic nerve to be registered in your brain, from which a message is sent to another part of your brain that controls your muscles. Your brain must then send a signal along the nerves to
your muscles, telling them to depress the mouse button. Signals travel fast along each of the nerve pathways required, however the majority of the reaction time is taken up at the junction points in between the different nerves involved, and between the nerves and the muscles at your fingers.

However, if you compare your results of the click reaction time to the 'make your own' test, you may notice that you get quite different scores, even though the tests are measuring similar abilities. The slight differences between the tests and the computer software may explain the different results you will get.

Reaction time is the interval time between the presentation of a stimulus and the initiation of the muscular response to that stimulus. A primary factor affecting a response is the number of possible stimuli, each requiring their own response, that are presented.

If there is only one possible response (simple reaction time) it will only take a short time to react. If there are several possible responses (choice reaction time) then it will take longer to determine which response to carry out.

Hick discovered that the reaction time increases proportionally to the number of possible responses until a point at which the response time remains constant despite the increases in possible responses (Hick's Law).

**Improving Reaction Speed**

**Reaction Time**

Reaction time itself is an inherent ability, but overall response time can be improved by practice. Coach and athletes need to analyse the type of skill and the requirements of their sport and decide where overall response gains can be made. Consider the following:
 Detecting the cue - in a sprint start, focusing on the starter's voice and the sound of the gun and separating this from background crowd noise and negative thoughts

 Detecting relevant cues - a goalkeeper learning to analyse body language at penalties

 Decision making - working on set pieces and game situations

 Change in attention focus - being able to switch quickly from concentration on the opponent to concentration on the field of play in invasion games

 Controlling anxiety - which slows reaction times by adding conflicting information

 Creating optimum levels of motivation - 'psyching up'

 Warm up - to ensure the sense organs and nervous system are ready to transmit information and the muscles to act upon it

 **Anticipation**

 Anticipation is a strategy used by athletes to reduce the time they take to respond to a stimulus e.g. the tennis player who anticipates the type of serve the opponent will use (spatial or event anticipation). In this case, the player has learnt to detect certain cues early in the serving sequence that predicts the potential type of serve. This means the player can start to position himself or herself for the return earlier in the sequence than usual and thus give themselves more time to play the shot when the ball arrives. Obviously, there are dangers for the tennis player in anticipating in this way but the advantages of getting it right are great.

 **Factors influencing response time**
Response time is the sum of reaction time plus movement time. Factors that may influence the performer's response are:

- Gender and age (see figure opposite)
- Stage of learning
- Psychological state
- Level of fitness
- Number of possible responses
- Time available
- Intensity of the stimuli
- Anticipation
- Experience
- Health
- Body Temperature - colder the slower
- Personality - extroverts react quicker
- State of alertness
Length of neural pathways

Interest in the measurement of human reaction time (the time elapsing between the onset of a stimulus and the onset of a response to that stimulus) apparently began as a result of the work of a Dutch physiologist named F. C. Donders. Beginning in 1865, Donders became interested in the question of whether the time taken to perform basic mental processes could be measured. Until that time, mental processes had been thought to be too fast to be measurable.

In his early experiments, Donders applied electric shocks to the right and left feet of his subjects. The subject's task was to respond by pressing a telegraph key with his right or left hand to indicate whether his right or left foot had received the shock. In one experimental condition the subject knew 'in advance' which foot was to receive the electric shock and in the other condition the subject did not know 'in advance' which foot was to receive the shock. Donders found that the difference between the two conditions was 1/15 second. This measurement represented the very first time that the human mind had been measured. Donders was apparently aware of the importance of his discovery because he wrote: "This was the first determination of the duration of a well-defined mental process. It concerned the decision in a choice and an action of the will in response to that decision."

Donders' ability to accurately measure such a short time interval was greatly facilitated by the solution of an earlier military problem. In 1840, the Englishman Charles Wheatstone invented a device for measuring the velocity of artillery shells. The device, which was based on his early electric telegraph system, was started electrically when the projectile left the muzzle of a gun and stopped electrically when it struck the target.
By 1842, a Swiss watchmaker named Mathias Hipp had improved on Wheatstone's design and began selling an instrument which used a tuning fork-like spring which vibrated at 500 Hz to repetitively engage the teeth of a wheel and thus regulate the speed of revolution of the wheel. Later models of his 'Hipp Chronoscope' had vibrating regulators which vibrated at 1000 Hz. This improved their accuracy.

The clockwork mechanism of the Hipp Chronoscope was caused to rotate continuously by a motor powered by a heavy weight. At the start of a reaction-time measuring trial, the mechanism was set in motion but prevented from moving the indicating hands on its dial by a clutch which was held in the disengaged position by an electrically-energized solenoid. When the electrical current through the solenoid was interrupted, the clutch engaged and the dial rotated rapidly. When the current was reestablished, the clutch disengaged and the dial stopped at a reading which showed the elapsed time in thousandths of a second.

An example of a Hipp Chronoscope from The Barnard College Psychology Department History of Psychology Collection.

Although Donders did not continue to pursue his interest in the reaction time, Wilhelm Wundt built an elaborate laboratory and research program around measuring the time taken by various mental processes. A student of the eminent and meticulous researchers, Hermann von Helmholtz and Emil Du Bois-Reymond, Wundt designed a psychology laboratory in Leipzig which was to become the model for dozens of scientific psychology laboratories throughout the world. His focus on the precise measurement of psychological processes or "MENTAL CHRONOMETRY" became the central issue in psychological research from the 1870's certainly into the 1950's. His insistence on precision of measurement has continued to influence the design of psychological experiments to the present.
Although the date 1879 is often given as the date of establishment of Wundt's first laboratory in Leipzig, it is clear that he was busy designing and performing precise measurements of human reaction times far earlier. His book: 'Grundzüge der physiologischen Psychologie' appeared in 1873 and contained a great deal of information about this new kind of psychological research.

**PROBLEMS WITH OBTAINING ACCURATE REACTION TIMES**

The Hipp Chronoscope was unfortunately prone to a number of serious problems which tended to produce inaccurate readings. Such inaccuracies were unacceptable to well trained students of Helmholtz such as Wundt and great efforts were expended in his laboratory to study the source of these errors and to correct them.

One major problem was that the vibrating spring escapement would, at unpredictable times begin to vibrate an octave lower at half its usual speed. This shift in vibration speed was often audible to the experimenter who would discard the data from that reaction time trial but the problem persisted and no solution was ever found. Experimenters simply had to listen closely to the pitch of the tone made by the machine and be ready to discard trials when the tone changed.

Another problem was caused by the time it took for the electric current to release and pull-in the solenoid which operated the clutch. The RELEASE TIME was highly dependent on the applied voltage. Low voltages allowed the mechanism to release immediately as soon as the voltage was removed from the coil. Higher voltages induced stronger magnetic fields into the core of the coil which took longer to decay after the voltage was removed and which held the clutch disengaged for a longer time after the voltage was removed. The PULL-IN TIME was also highly dependent on the applied voltage. Low voltages pulled in the mechanism slowly due to the fact that they built up sufficient magnetic flux to operate the clutch slowly. High voltages
pulled in the mechanism rapidly due to the fact that they built up magnetic flux rapidly. To help with this problem, the Hipp Chronoscope was always used in conjunction with a voltmeter which helped to assure that the same voltage was being applied to the coils on every trial.

However, since 'wet' chemical batteries were used, the amount of current that they could provide varied throughout the day as did their voltage and this led to considerable variability in the measurements.

These problems were perceived as major obstacles to the development of a precise 'science' of psychology as the developing field of psychology struggled to portray itself as a science with a rigorous scientific method on a par with that of the natural sciences.

**THE CONTROL HAMMER**

Another device was invented to act as a calibration standard for the Hipp Chronoscope. It was designed to produce an absolutely accurate interval of time between opening its electrical contacts and closing them. It was called the 'CONTROL HAMMER' and it was quite literally a falling hammer-like weight which opened and closed electrical contacts as it fell by them. An electromagnet released the hammer and it fell past one electrical contact which opened the circuit to the Hipp Chronoscope, engaging its clutch and starting it measuring time. When the hammer fell past a second electrical contact, the circuit was closed. This disengaged the clutch on the Hipp Chronoscope and stopped its dial from moving. The 'control hammer' was supposed to provide an absolutely reliable time interval which could be used to calibrate and check on the operation of the Hipp Chronoscope.

Unfortunately, the control hammer itself needed to be calibrated. In order to know exactly how long the 'constant' interval provided by the control hammer was, another
device which could accurately measure extremely small time intervals was needed. This device was the 'chronograph'.

**THE CHRONOGRAPH**

The chronograph consisted of a rotating cylinder covered with a soot-smoked piece of paper. The black soot on the paper allowed a beard-hair to leave a mark on the paper as the cylinder rotated. The beard hair was glued to a tuning fork which vibrated at exactly 1000 Hz (vibrations-per-second). Thus, a wavy line was drawn on the smoked paper with each wave indicating the passage of 1 millisecond (1/1000 second).

Lightweight electrical solenoids put other marks on the paper when the clutch of the Hipp Chronoscope was engaged and disengaged by the control hammer apparatus and the number of waves on the paper which separated these marks indicated the time duration in milliseconds.

The chronograph, then, calibrated the control hammer which calibrated the Hipp Chronoscope which measured the reaction times of the subject.

**WUNDT'S RESEARCH**

Although a significant portion of each day was spent in laboriously calibrating the Hipp Chronoscopes, Wundt gradually collected measurements of a wide variety of mental phenomena.

**The Importance Of Reaction Time In Sports Performance**

Reaction time is the ability to respond quickly with proper posture and control to a stimulus such as sound or sight. In many instances, quickness is more important than straight ahead speed. In many sports, maximum speed is rarely reached or needed, but explosive reaction is often necessary. Athletes can improve reaction times by training to make the right choices (choice reaction).

Here are some examples:
1) A defensive back makes an interception because he reads the quarterbacks eyes/motions, reads the receiver's body moves, positions his body based on the receiver's actions and reacts to the thrown ball. These different stimuli could happen in any order. The most successful defensive backs anticipate, react quickly and explosively with proper posture and control.

2) One of the most important decisions a batter makes at the plate is to "go" or "no go" i.e., whether to swing the bat or not swing. The most successful hitters are able to wait longer and react quicker. This allows the batter to read the pitch (fastball, curve, etc.) and "go" or "no go". When facing a 90+ per hour fastball, there's not much time to react.

3) Reaction time drills should be done from an athletic stance, staggered stance, kneeling position, back-to-ball position, eyes-closed position, two-point stance, etc. to simulate game-time situations. Reaction time and explosive quickness is an important part of overall speed training and the best athletes have this quality.

**EXERCISE AND REACTION TIME**

The problem we tested was the effect of exercise on reaction time. From previous knowledge we knew that increased heart rate produces adrenaline which prepares the body for fight or flight response and in addition causes pupil dilation. Increased pupil dilation is a defense strategy, to enable one to see farther, and a faster response to stimuli. We hypothesized that increased heart rate has an effect on reaction time.

To test the hypothesis, we conducted a two-dependant test by comparing the reaction time of a subject at a resting heart rate and at an increased heart rate after exercise. In each trial, subjects were tested using a reaction meter. The subjects were asked to place their hand twelve inches away from the button, and react to the light
going on by pushing the button underneath the light as quickly as possible. Only one light was used to keep consistency. Each subject had ten trials, and two tests, one before and one after exercise. Our prediction was that exercise would make reaction time faster due to increased pupil dilation.

Our results indicated that increased heart rate did in fact have a significant effect on the reaction time. The average reaction time at resting heart rate was 0.6795 seconds, and the reaction time after the five minute aerobic workout was 0.5852 seconds. A T-test gave us a P-value of 0.00387923, which indicates that exercise does in fact have a significant effect on reaction time. As means to the explanation why, pupil dilation was also measured before and after exercise. At resting heart rate, an average of 5.3435 mm was recorded, and following the exercise, average dilation was 6.19875 mm. This increase of dilation resulted in an average of 0.85525 mm, and the significance is supported by another T-test with a P value of 0.002403307. Our hypothesis and predictions are supported by our data.

According to a study done at the Graduate School of Sport Science, Osaka University of Health and Sport Sciences, in Osaka, Japan, results found that visual reaction time increased with acute exercise from that at rest. In this experiment by Ando S. et al. (2008), twelve participants were tested before and after using a stationary bike as an aerobic exercise. Other studies showed trends in reaction time do to arousal or state of attention. This state of attention also includes muscular tension that can be generated by exercise. Etnyre and Kinugasa et al. (2002) found that muscular tension allowed the brain to work faster, although muscular tension did not affect movement time. The study of Davranche et al. (2006) also showed similar results, concluding that exercise improved reaction time by increasing arousal. Though, numerous studies by Welford (1980), Broadbent (1971), and Freeman
(1933), showed that reaction time deteriorates when the subject is either too relaxed or too tense. This study indicated that reaction time was fastest with an intermediate level of arousal.

**Reaction time:**

The time that elapses between a stimulus and the response to it.

Mental chronometry is studied using the measurements of reaction time (RT). Reaction time is the elapsed time between the presentation of a sensory stimulus and the subsequent behavioral response. In psychometric psychology it is considered to be an index of speed of processing. That is, it indicates how fast the thinker can execute the mental operations needed by the task at hand. In turn, speed of processing is considered an index of processing efficiency. The behavioral response is typically a button press but can also be an eye movement, a vocal response, or some other observable behavior.

*Simple* reaction time is the motion required for an observer to respond to the presence of a stimulus. For example, a subject might be asked to press a button as soon as a light or sound appears. Mean RT for college-age individuals is about 160 milliseconds to detect an auditory stimulus, and approximately 190 milliseconds to detect visual stimulus. The mean reaction times for sprinters at the Beijing Olympics were 166 ms for males and 189 ms for females, but in one out of 1,000 starts they can achieve 109 ms and 121 ms, respectively. Interestingly, that study concluded that longer female reaction times are an artifact of the measurement method used; a suitable lowering of the force threshold on the starting blocks for women would eliminate the sex difference.

*Recognition* or *Go/No-Go* reaction time tasks require that the subject press a button when one stimulus type appears and withhold a response when another stimulus type
appears. For example, the subject may have to press the button when a green light appears and not respond when a blue light appears.

*Choice* reaction time (CRT) tasks require distinct responses for each possible class of stimulus. For example, the subject might be asked to press one button if a red light appears and a different button if a yellow light appears. The Jensen box is an example of an instrument designed to measure choice reaction time.

*Discrimination* reaction time involves comparing pairs of simultaneously presented visual displays and then pressing one of two buttons according to which display appears brighter, longer, heavier, or greater in magnitude on some dimension of interest.

Due to momentary attentional lapses, there is a considerable amount of variability in an individual's response time, which does not tend to follow a normal (Gaussian) distribution. To control for this, researchers typically require a subject to perform multiple trials, from which a measure of the 'typical' response time can be calculated. Taking the mean of the raw response time is rarely an effective method of characterizing the typical response time, and alternative approaches (such as modeling the entire response time distribution) are often more appropriate.